Trends and cycles in the Euro Area: how much heterogeneity and should we worry about it?*

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Abstract

Not so much and we should not, at least not yet.

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1 Introduction

Recently, the policy discussion has focused on heterogeneity of economic performance of countries in the European Monetary Union (EMU). The mechanisms through which the lack of flexibility based on national exchange rate and monetary policy may exacerbate the effect of shocks is well known (see Mundell, 1961, and subsequent literature) and the potential effect of common monetary policy on increasing divergence of economic performance between countries belonging to the union have been widely debated in the late nineties.

Now, six years after the establishment of the monetary union, with some real observations to analyze and with the Euro Area facing unsatisfactory growth performance, the debate is having a second life. Heterogeneity is indeed the subject of this conference.

This paper looks at this issue from a narrow point of view. We analyze output dynamics in member countries in the last thirty years and try to establish robust stylized facts on output differentials within the union, the synchronization of recessions and the relation with respect to the US. Recent developments, we argue, have to be understood within the broader picture of the historical behavior of the European countries business cycle and their relation with the US. The ambition of the paper is to organize the results of a large empirical literature and bring some new evidence on our own to provide an understanding of the stylized facts.

This analysis leads us to the following results. Output differentials, both in term of levels and growth rate, have been remarkably stable over the last thirty years. However, the business cycle have shown a high degree of synchronization: recessions have occurred at similar dates and cross-country correlations have been stable and in line with those found amongst US regions.

An analysis of the shocks suggests that heterogeneity is explained by small, but persistent idiosyncratic shocks while output fluctuations are mainly explained by common Euro Area shocks with similar propagation mechanisms. This indicates that the roots of recent heterogeneity has to be found in national shocks, such as policies, for example, that have a long lasting effect, but that are small when compared with common forces of variation.

Our ambition is not structural here and this evidence is meant to provide food for thought for a deeper analysis. Any structural analysis will have to match these two facts: common dynamics and small and persistent idiosyncratic shocks. Persistence of gaps in output per capita is explained, for Euro Area core countries, such as Germany, France and Belgium by very long swings in the gap while for other countries, such as Ireland, by convergence effects. Given the short sample we base this analysis on, it is difficult to assess whether, since the early nineties, with the deepening of the European integration, convergence effects dominate.

When the Euro Area is analyzed as a whole and in combination with the US, it appears that the two currency areas have a large component of their output fluctuations in common. Fluctuations are generated by a world shock originating in the US, a shock that Europe absorbs with a lag and with a response which is less volatile, but more persistent. This is food for thought for a deeper understanding of international linkages: what explains the difference between growth performance of the Euro and the US does not seem to be the nature of the shocks, but rather the propagation mechanism. This result is based on a more detailed analysis in (Giannone and Reichlin, 2005) and is in line with the literature that emphasized the importance of world shocks (eg. Kose et al., 2003; Canova et al., 2004). However, it qualifies that result showing US-Euro Area differences in the propagation mechanism to the common shocks.

In the last part of the paper, we turn to the analysis of recent changes and we ask whether, in faces of the output development just described, we have observed a higher degree of risk sharing and therefore a higher degree of consumption cross-country correlations conditionally on output. Our analysis follows Asdrubali et al. (1996) and Kalemli-Ozcan et al. (2004). It points to evidence of a higher degree of risk sharing which leads us then to conclude that EMU, and more generally European integration, seems to have worked in the right direction. Obviously, whether this process will eventually lead to higher growth in the aggregate is still unclear, but the understanding of this link should be in the research agenda.

2 Output heterogeneity within the Euro Area

2.1 Synchronization of output levels, growth rates and recessions

The literature has analyzed synchronization from different points of views: levels, growth rates, the unravelling particular episodes such as recessions, by using data filtered so as to capture business cycle frequencies. However, not much has been done to try to connect the findings from the different perspectives. In this section we will try to fill this gap.

Level gaps

A first natural measure of asymmetry can be defined looking at the difference between output per capita in a member country and the average in the Euro Area.

Define $y_t^i \times 100$ as the log of real GDP per-capita of country (region) i in year t (PPP adjusted). The gap with respect to an aggregate Euro Area wide (US wide), y_t^{AV},

$$\text{gap}_t^i = y_t^i - y_t^{AV}$$

is defined as the percentage deviation of real GDP per-capita of country (region) i with respect to the aggregate Euro Area (US) GDP per-capita.

The level gap is linked to growth differentials by the expression:

$$\text{Gap}_{t+h}^i = \text{Gap}_t^i + \sum_{s=1}^{h} +\Delta\text{Gap}_{t+s}^i$$

where

Table 1: *Per-capita GDP at PPP and 2000 prices: gap with respect to Euro Area*

	1970	1980	1990	1999	2003	AVE 70-03	AVE 70-89	AVE 90-03	AR1	
AT	6.32	13.13	12.88	16.49	15.67	13.18	11.90	15.01	0.81	*
BE	5.05	8.51	6.16	7.00	7.00	6.81	7.02	6.52	0.51	**
FI	-2.00	2.89	7.77	3.57	8.05	2.54	3.77	0.78	0.88	*
FR	10.76	9.81	7.92	4.83	5.05	8.38	10.35	5.56	0.98	
GE	5.54	4.55	5.04	3.63	1.53	4.47	4.15	4.92	0.90	
GR	-29.51	-21.33	-40.63	-41.28	-30.79	-31.85	-26.07	-40.12	0.94	
IE	-44.63	-40.13	-28.50	10.40	23.84	-25.72	-40.71	-4.30	1.07	
IT	1.74	4.94	5.91	2.86	2.26	3.88	3.69	4.14	0.93	
LU	34.23	25.07	47.79	65.91	72.24	43.60	31.86	60.37	1.04	
NL	17.73	10.73	6.47	11.85	8.58	10.38	11.47	8.82	0.90	
PT	-57.78	-50.34	-40.59	-33.55	-37.06	-45.04	-50.65	-37.01	0.92	
SP	-25.61	-27.73	-23.23	-17.25	-13.64	-22.65	-24.68	-19.75	1.01	
EU12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
DE	31.80	19.43	13.78	16.26	15.57	19.90	23.23	15.15	0.88	
SE	24.73	13.29	11.15	8.96	11.34	13.03	16.82	7.63	0.88	
UK	6.71	-2.64	0.90	4.27	7.59	2.26	2.00	2.65	0.84	
EU15	2.31	0.23	0.62	1.14	1.73	1.01	1.13	0.84	0.81	
US	36.31	30.35	31.95	35.54	35.48	33.38	33.62	33.04	0.66	**
CA	19.48	18.73	12.79	12.89	15.98	15.93	19.25	11.20	0.90	
JP	-4.04	0.20	12.35	7.20	6.79	5.20	1.46	10.54	0.92	
OECD	3.72	-0.13	0.84	1.58	1.94	1.43	1.70	1.04	0.61	**

The last column denotes the results from an ADL test for unit root.
, **, and *** indicate if the Unit Root is rejected at 10% and 5 % and 1% level respectively

$$\Delta \text{Gap}^i_{t+s} = \Delta y^i_{t+s} - \Delta y^{AV}_{t+s}.$$

The gap observed today $(t+h)$ in a given country then depends on its initial (time t) relative condition and growth performance in the past years up to today $(t+1, ..., t+h)$.

We ask two main empirical questions. Do gaps persist in time? Have countries changed their relative position?

Table 1 reports the gaps for Euro countries in the last 30 years. We also report gaps for the US, Japan (JP), Canada (CA), and, respectively, the Euro twelve (EU12)[1], the European Union with the 15 members preceding the 2004 enlargement (EU15)[2], and the OECD countries for comparisons.

Table 2 reports the same gap statistics for the real personal income of US regions with respect to the US average.[3] We consider the following regions: New England (NE),Mideast (ME), Great Lakes (GL), Plains (PL), Southeast (SE), Southwest (SW), Rocky Mountain (RM), Far West (FW).

Table 1 shows that the gaps, with the exception of Ireland, have been remarkably stable in the last thirty years. These gaps are also very persistent and there is no clear sign of convergence to a common level of output per capita (again with the exception of Ireland).

[1]Austria (AT), Belgium (BE), Finland (FI), France (FR), Germany (GE), Greece GR, Ireland (IR), Italy (IT), Luxembourg (LU), Netherland (NE), Portugal (PT) and Spain (SP).

[2]EU12 plus Denmark (DE), Sweden (SE) and United Kingdom (UK).

[3]The use of personal income in Table 2 rather than GDP as in Table 1 will lead us to overestimate similarities between US regions and the US aggregates with respect to the European nations case.

Table 2: *Per-capita Personal Income: Gap of US region with respect to US aggregate*

	1970	1980	1990	1999	2003	AVE 70-03	AVE 70-89	AVE 90-03	AR1
US	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NE	8.45	4.97	15.37	17.03	19.02	11.50	7.98	16.53	1.00
ME	12.11	7.55	14.88	13.02	13.20	11.50	10.09	13.52	0.96
GL	2.61	1.70	-1.93	-0.08	-1.40	0.53	1.36	-0.67	0.94
PL	-6.18	-5.66	-7.17	-4.40	-3.15	-4.47	-4.21	-4.83	0.55
SE	-20.65	-15.65	-12.05	-10.99	-10.02	-13.61	-15.69	-10.64	0.92
SW	-12.56	-4.30	-13.26	-10.41	-10.69	-9.69	-8.60	-11.24	0.91
RM	-8.21	-3.04	-11.35	-5.83	-4.33	-6.59	-6.24	-7.07	0.93
FW	13.58	14.36	8.29	5.39	4.47	9.16	11.86	5.30	0.98

The last column denotes the results from an ADL test for unit root.
*, **, and *** indicate if the Unit Root is rejected at 10% and 5 % and 1% level respectively

A formal unit root test, whose results are shown in the last column, indicates that for most European countries we cannot reject the hypothesis that the gap is non-stationary and that therefore there is no common trend along which these economies move.

Persistence in the gaps is generated by low frequency cycles around different means and, in the case of Ireland by a convergence trend. Given the persistence of the gaps it is difficult to distinguish whether, since the EMU, countries such as Spain or Greece have been moving along a convergence path or are just in a phase of a long swing. In general, on the basis of data so far, there is no clear evidence that the EMU has modified the historical dynamics.[4]

To put these findings in a broader context, it is useful to look at the gap between the US and the Euro Area average (Table 1) and the US regions and the US aggregate (Table 2). From Table 2, we can see that the gaps between US regions and the US aggregate, like the gaps between Euro Area countries and the Euro Area average are non-stationary while, from Table 1, we had found that the gap between the US and the Euro Area is. This fact suggests that it is indeed more likely for large economic entities, which by virtue of size, are well diversified to move along a similar path over a period of thirty years. Averaging output over nations/regions "kills" idiosyncratic fluctuations, no matter whether they are persistent or not. To understand the economic importance of this finding, however, we need to estimate the size of this idiosyncratic dynamic. This is what we will do in the next Section.

Growth gaps

Contrary to the level gaps, the variance of growth rates gaps:

$$\mathrm{Var}(\Delta y_t^i - \Delta y_t^{EU})$$

[4]A separate literature has studied convergence dynamics within the Euro area (eg, Harvey and Carvalho, 2005) and proposed formal statistical tests. This analysis is not the focus of this paper.

have declined over time and, in the last ten years, has reached an historical low (see Table 3, column 1). This is not true, however, if we look at correlations between country's growth and Euro average growth, $\text{Corr}(\Delta y_t^i, \Delta y_t^{EU})$. Since, as observed by many studies (see Stock and Watson, 2005, for a review of the literature and an analysis based on the G7), the variance of output per capita has decreased everywhere, a phenomenon that has been labelled the "great moderation", correlations are more stable than the variance of the gaps.

Table 3 reports variances of GDP growth rates, variances of the growth gap and correlations between our selected countries and Euro Area GDP growth rates, for different sub-samples.

Table 3: GDP growth rate for OECD countries: descriptive statistics

	(1) $\text{Var}(\Delta y_t^i - \Delta y_t^{EU})$			(2) $\text{Var}(\Delta y_t^i)$			(3) $\text{Corr}(\Delta y_t^i, \Delta y_t^{EU})$		
	71-03	71-89	93-03	71-03	71-89	93-03	71-03	71-89	93-03
AT	1.24	1.96	0.38	2.86	3.56	1.32	0.76	0.68	0.84
BE	0.71	1.01	0.43	3.16	3.97	1.44	0.88	0.87	0.84
FI	7.31	3.57	1.17	8.46	3.79	2.18	0.38	0.43	0.68
FR	0.38	0.43	0.15	1.91	1.90	1.14	0.91	0.90	0.93
GE	0.71	0.64	0.06	2.91	2.79	0.94	0.87	0.88	0.97
GR	9.07	13.21	2.29	10.94	16.85	1.04	0.41	0.48	-0.20
IE	8.66	6.00	3.57	8.25	4.92	6.43	0.20	0.18	0.79
IT	0.88	1.19	0.26	3.21	3.97	0.82	0.85	0.84	0.85
LU	7.17	8.74	4.56	10.95	14.58	7.20	0.62	0.70	0.70
NL	1.03	1.01	0.90	2.49	2.69	2.69	0.78	0.80	0.87
PT	6.65	10.25	2.04	13.05	18.62	4.09	0.82	0.82	0.77
SP	2.00	3.15	0.24	4.05	5.71	0.87	0.71	0.67	0.86
EU12	0.00	0.00	0.00	2.05	2.29	0.86	1.00	1.00	1.00
DE	2.72	3.53	1.07	3.58	5.02	1.70	0.54	0.56	0.62
SE	3.32	3.50	0.52	3.36	2.13	1.82	0.40	0.21	0.86
UK	3.21	3.22	0.44	3.81	5.10	0.63	0.47	0.61	0.71
EU15	0.10	0.10	0.01	1.85	2.21	0.77	0.97	0.98	0.99
US	3.25	3.69	1.03	4.16	5.83	1.33	0.51	0.61	0.54
CA	3.68	2.59	0.96	4.57	4.31	2.13	0.48	0.64	0.75
JP	3.32	3.16	3.41	4.47	4.37	2.19	0.53	0.55	-0.13
OECD	0.85	0.85	0.48	1.90	2.60	0.68	0.79	0.83	0.69

To control for the effects of the German unification, we do not include the period 1990-1992 in the sub-samples.

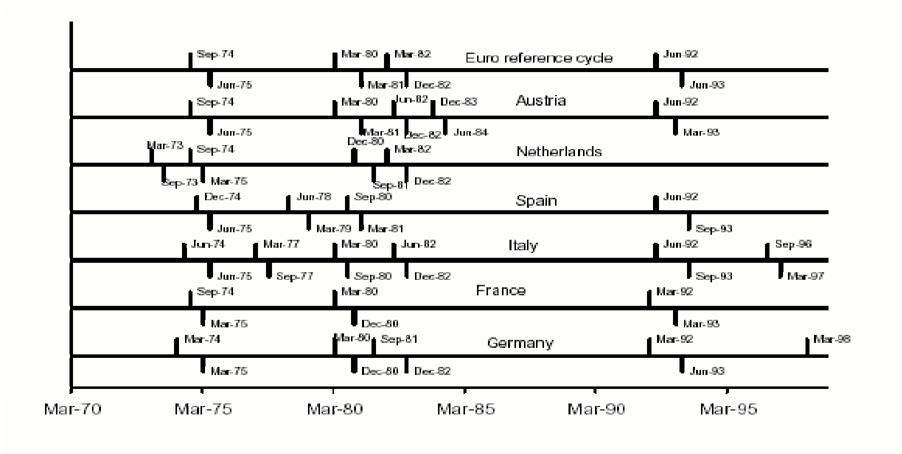
The table shows that cyclical co-movements, measured by correlations have been high and stable within the Euro Area and between the Euro Area and the rest of the world.

This finding is in line with (Stock and Watson, 2005) who analyze the international business cycle using different measures and with the literature on the world business cycle which has found that the international component of output fluctuations explain a large part of total volatility (e.g. Kose et al., 2003; Artis et al., 2004; Canova et al., 2004; Monfort et al., 2004). Simple correlation coefficients, however, show that co-movements within the Euro Area, are higher than between the Euro Area and the rest of the world. This indicates that the Area wide aggregate captures the bulk of national features and that we can identify specific characteristics of the Euro Area business cycle. This justifies the analysis of the aggregate European business cycle with respect to the US which we carry on in Section 4.

Recessions

Recessions are very informative events. In "normal times" volatility is relatively low while a recession is a major event, characterized by an unusual drop in output. Are Euro Area recessions synchronized? Harding and Pagan (2004) have recently proposed an adaptation of the automatic algorithm designed by Bry and Boschan (1971) to identify peaks and through of the European recessions of the last thirty years [5]. Figure 1 reports their resulting dating for the Euro area and its largest member countries.

Figure 1: Euro Area Classical Reference Cycle and specific cycles in GDP for individual Euro Countries (Source: Harding and Pagan (2004))



The Figure shows that peaks and troughs of European countries business cycles are basically concomitant.

Summing up

An apparent paradox emerges from a first look at the economic performances of European countries: looking at levels of economic activity we would be led to think that differences between countries are persistent while looking at growth rates or at the chronology of the business cycle we find strong similarities. The explanation is that cyclical asymmetries when measured in terms of levels of output, although persistent, are small and in line with those between US regions.

In the next sub-section we will analyze the sources of asymmetries in more details.

[5] The Bry-Boschan algorithm is a non-parametric procedure deviced to identify local maxima and minima and it is widely used in business cycle analysis.

2.2 What drives asymmetries: shocks or propagations?

Heterogeneous dynamics can be explained either by the exogenous sources of variation, i.e. idiosyncratic, country-specific shocks or by heterogenous responses to common shocks. Which is the explanation for the heterogeneity found within the Euro Area?

To analyze this question, we estimate a set of bivariate structural VARs on output per capita of country i and the Euro area average. The identification assumption is that the country specific shock affects the other member countries with a lag, one year, i.e. we assume that spillover effects take at least one year to manifest[6].

We will use the US as the usual benchmark and redo the exercise using regional output and US average.

The model is

$$\begin{pmatrix} y_t^{AV} \\ y_t^i \end{pmatrix} = \begin{pmatrix} \mu^{AV} \\ \mu^i \end{pmatrix} + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} y_{t-1}^{AV} \\ y_{t-1}^i \end{pmatrix} + \begin{pmatrix} b_{11} & b_{22}p_i \\ b_{21} & b_{22} \end{pmatrix} \begin{pmatrix} u_t^{AV} \\ u_t^i \end{pmatrix}$$

where p_i is the relative size of country (region) i measured as the ratio between county (region) i population and the total population of the Euro Area (United States)[7]. As in Section 2, The superscript AV indicates Euro Area (US) aggregate measure and the u_t^{AV} is the Euro Area Wide (US wide) shock while u_t^i is the country (region) i specific shock[8].

To understand which shocks are responsible for the asymmetries we will look at the cumulative effects of country specific shocks on the growth gap, i.e. at the estimate of:

$$\frac{\partial \sum_{s=1}^{h} \left[\Delta y_{t+s}^i - \Delta y_{t+s}^{AV}\right]}{\partial u_t^i}, \quad h = 1, 3, 5$$

and at the cumulative effects of country specific shocks on the country output growth

$$\frac{\partial \sum_{s=1}^{h} \left[\Delta y_{t+s}^i\right]}{\partial u_t^i}, \quad h = 1, 3, 5$$

Euro Area

Table 4 below shows forecast error decompositions related to these two quantities for the Euro Area.

[6] A similar identification strategy has been used by Stock and Watson (2005) to identify country specific and world-wide shocks among G7 countries.

[7] We use average population over the sample period 1970-2003.

[8] The VAR is estimated in levels to be robust with respect to unit root issues. Impulse responses will be then computed for a medium run horizon.

Table 4: Percentage of forecast error due to country specific shocks

	$\sum_{s=1}^{h}\left[\Delta y_{t+s}^{i}-\Delta y_{t+s}^{EU}\right]$					$\sum_{s=1}^{h}\left[\Delta y_{t+s}^{i}\right]$			
	h=0	h=1	h=3	h=5		h=0	h=1	h=3	h=5
AT	0.91	0.92	0.93	0.92		0.42	0.30	0.17	0.11
BE	1.00	1.00	1.00	1.00		0.24	0.14	0.10	0.11
FI	0.99	0.99	0.99	0.99		0.87	0.87	0.85	0.84
FR	0.76	0.74	0.69	0.66		0.26	0.21	0.14	0.10
GE	0.96	0.96	0.96	0.96		0.48	0.46	0.42	0.39
GR	0.98	0.98	0.97	0.96		0.91	0.90	0.87	0.84
IE	0.98	0.98	0.99	0.99		0.86	0.85	0.83	0.82
IT	0.98	0.98	0.98	0.98		0.46	0.45	0.43	0.41
LU	0.78	0.76	0.71	0.67		0.43	0.41	0.38	0.36
NL	0.98	0.98	0.99	0.99		0.39	0.39	0.39	0.38
PT	0.70	0.69	0.67	0.65		0.38	0.35	0.31	0.27
SP	0.99	0.99	1.00	1.00		0.63	0.64	0.65	0.66

From the Table we can see that the gap is mainly explained by country specific shocks at all horizons. The latter, however, have had a limited role in explaining output fluctuations, particularly at medium term horizon. Three exceptions stand out: Greece, Finland and Ireland.

A further exercise is to run a counterfactual exercise and ask what would have correlation been in the absence of country specific shocks. Table 5 below provides the answer.

Table 5: Counterfactual correlations

	TRUE	Only Area Wide Shocks	Only Country specific Shocks
AT	0.76	0.94	0.20
BE	0.88	0.97	0.32
FI	0.38	0.96	0.07
FR	0.91	0.97	0.21
GE	0.87	0.88	0.35
GR	0.41	0.90	0.16
IE	0.20	0.34	-0.12
IT	0.85	0.98	0.31
LU	0.62	0.81	-0.11
NL	0.78	0.97	0.08
PT	0.82	0.99	0.15
SP	0.71	0.97	0.18

Clearly, correlations would have been quite high and stable if there had been only area-wide shocks which implies that asymmetries are explained by idiosyncratic shocks rather than heterogeneous responses to common shocks and that, therefore, area wide shocks propagate similarly across Euro Area countries (with the exception of Ireland).

Again we find that, although small, national factors have persistent effects. Common Euro Area shocks account for the bulk of business cycle fluctuations.

The US

Table 6 and Table 7 below report results for the US regions from the same exercises we performed for Euro Area's countries.

Table 6: Percentage of forecast error due to region specific shocks

	$\sum_{s=1}^{h}\left[\Delta y_{t+s}^{i}-\Delta y_{t+s}^{EU}\right]$					$\sum_{s=1}^{h}\left[\Delta y_{t+s}^{i}\right]$			
	h=0	h=1	h=3	h=5		h=0	h=1	h=3	h=5
NE	0.96	0.94	0.90	0.84		0.25	0.23	0.19	0.16
ME	0.93	0.94	0.96	0.96		0.20	0.19	0.16	0.14
GL	0.98	0.99	0.99	0.99		0.19	0.18	0.17	0.16
PL	0.99	0.99	0.99	0.99		0.36	0.28	0.18	0.14
SE	0.94	0.95	0.96	0.97		0.11	0.13	0.17	0.20
SW	0.95	0.94	0.94	0.93		0.47	0.45	0.42	0.38
RM	0.94	0.94	0.94	0.94		0.37	0.34	0.29	0.24
FW	1.00	1.00	0.99	0.98		0.22	0.19	0.14	0.11

Table 7: Counterfactual correlations

	TRUE	Only US Wide Shocks	Only Region specific Shocks
NE	0.85	0.97	0.03
ME	0.91	0.99	0.11
GL	0.93	0.99	0.11
PL	0.80	0.99	0.09
SE	0.96	0.98	0.15
SW	0.77	0.97	0.12
RM	0.81	0.99	0.08
FW	0.92	0.99	0.15

Results are similar to the European case, although in the US the size of idiosyncratic shocks is more homogeneous across regions than it is for nations within the Euro Area. Three results emerge: (i) the gaps are mainly explained by region specific shocks in particular at medium horizons; (ii) output fluctuations are mainly explained by the US wide shocks at all horizons; (iii) correlations would have been quite high and stable if there had only been US-wide shocks, suggesting that US wide shocks propagate similarly across US regions.

3 The Euro Area and the world

So far we have concluded that (i) the global component of the Euro area countries fluctuations is large, but that (ii) Euro Area countries seems to be more correlated amongst themselves than with the rest of the world.

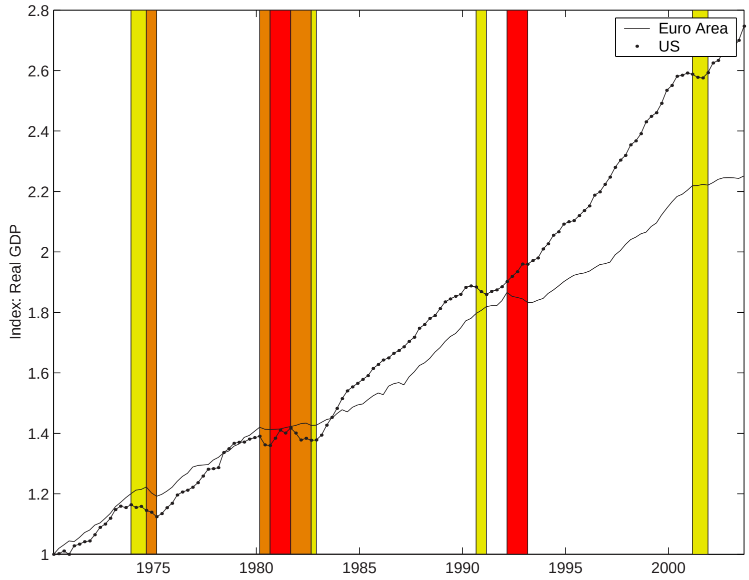
To explore further this point, in this Section, we will develop a simple statistical model to understand the relation between the Euro Area considered as an aggregate and the US as a whole. This analysis draws from Giannone and Reichlin (2005).

Let us first start with some descriptive statistics.

The National Bureau of Economic Research (NBER) and the Center for Economic Policy Research (CEPR) provide a chronology for, respectively, the US and the Euro Area business cycle. In both cases the chronology is established by informal inspection of a variety of key macroeconomic time series and it is not just based on GDP. The dates refer to what is typically called the classical cycle, i.e. the turning points in the *level* of economic activity. Figure 2 plots quarterly US and Euro Area GDP since 1970 (the first date for which aggregate euro statistics are available) and dates established by CEPR and NBER.

NBER and CEPR dating illustrate striking similarities between the cyclical characteristics of the two economies. In both economies, recessions are rare and of short duration if compared with expansions and they are roughly synchronized.

Figure 2: GDP since 1970



The light shadow corresponds to a recession in the US, the dark one to a recession in the Euro Area and overlapping recessions show with an intermediate shade

We will now compute some descriptive statistics on duration, amplitude and synchronization of cycles to document further similarities and differences between the two business cycles. Table 8 reports statistics for the two classifications of peaks and troughs: the informal CEPR and NBER classification (bold figures) and the dating resulting from the application of the automatic algorithm designed by Bry and Boschan (1971) to quarterly GDP[9] (in parenthesis). Amplitude is measured as the quarterly average growth rate of GDP during the sub-period, duration is measured in quarters while the concordance index is a measure of synchronization developed by (Harding and Pagan, 2004). Calling the log of US GDP as y_t^{US} and the log of Euro Area output as y_t^{EU}, the concordance index is defined as:

$$C_{ij} = \frac{1}{T}\sum_{t=1}^{T}[S_{y_t^{US}} S_{y_t^{EU}} + (1 - S_{y_t^{US}})(1 - S_{y_t^{EU}})]$$

where $S_{y_t^j}$ is a binary random variable that takes the values unity during recessions and zero during expansions. The concordance index ranges between 0 and 1.

The Table shows that, as suspected by inspection of Figure 2, there is high concordance between the two cycles. However, in the US cyclical amplitude is larger and

[9]For the BB algorithm, we have applied the parametrization suggested by Harding and Pagan (2002). We would like to stress that, following the tradition of Business Cycle dating, quarterly GDP is not in per-capita for our dating exercise.

Table 8: Business Cycle Statistics

	US	Euro Area
peak to trough amplitude	**-0.5658** (-0.6294)	**-0.2433** (-0.4979)
trough to peak amplitude	**0.9445** (0.9589)	**0.7653** (0.6254)
peak to trough duration	**3.4000** (3.4000)	**5.3333** (2.5000)
trough to peak duration	**23.25** (23.500)	**29** (35.00)
n. of recessions	**5.00** (5.00)	**3.00** (4.00)
Concordance Index	**0.8593** (0.8222)	

The business cycle statistics corresponding to the NBER and CEPR dating are in bold. We show in parentheses the same statistics, produced by the Bry-Boschan Dating Algorithm.

recessions are shorter than in the Euro Area. In general, the Euro area cycle seems to be smoother than the US one.

The analysis in terms of growth rates brings further insights on differences and similarities between business cycles. Since the growth of output is typically stationary, growth cycle characteristics can be illustrated by looking at volatility, persistence and dynamic correlations.

Volatility is typically measured by the variance of the growth rate of the series. This is an average of the variance at all frequencies and therefore captures short-run, medium/long-run and business cycle variance. The medium/long run, persistent component, can be measured in different ways. We will here define it as the centered 5-year average growth rate:

$$MA_5(\Delta y_t^i) = \frac{1}{5}\sum_{j=-2}^{2} \Delta y_{t+j}^i, \quad i = EU, US$$

Persistence can hence be measured as the ratio between the volatility of the medium/long run component and the total volatility. Table 9 reports the variance of the growth rates of output, the variance of the medium/long run component and the ratio between the latter and the former for both the Euro and the US economy. We can observe the following characteristics:

1. Total output volatility is higher in the US than in the Euro area.

2. Medium/long run output volatility is similar in the US and in the Euro Area.

3. The Euro cycle is more persistent than the US cycle. Persistence, as measured

by the ratio between the variance of the medium/long run component and the total variance, is larger in the Euro Area.

Table 9: Variance of the growth rate of output and of its 5 year centered moving average

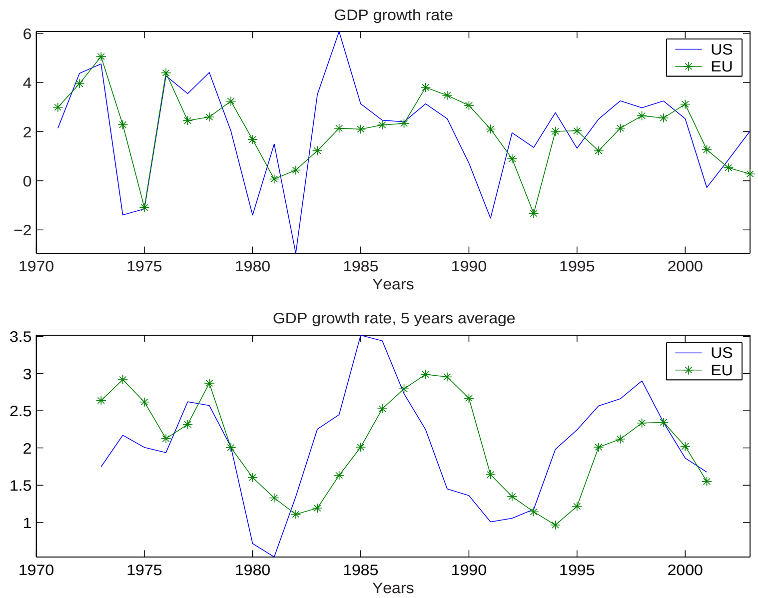
	US	Euro Area
(a) $var[\Delta y]$	4.50	2.00
(b) $var[MA_5(\Delta y)]$	0.55	0.40
(c)=(b)/(a) $\times 100$	12%	20%

Differences in volatility and persistence characteristics of growth cycles between the US and the Euro Area are the same as what observed for level cycles based on amplitude and duration statistics. Larger persistence in the Euro Area is not surprising, since recessions, as we have seen, are less pronounced, but last longer than in the US.

What about synchronization?

Figure 3 plots growth rates of GDP per-capita (upper quadrant) and its 5-years centered average (lower quadrant) corresponding. The plot shows the the Euro Area growth seems to "follow" the US's: the persistent component of output growth in the Euro Area is lagging the US analog.

Figure 3: GDP growth rates and potential growth



To understand whether this leading-lagging pattern implies a predictive relation between US growth and Euro Area growth, we run a simple Granger causality tests between growth rates of each area and the Euro Area-US gaps.

Table 10: *Granger causality test*

			F stat.	p-value
Δy_t^{US}	does not Cause	$y_t^{EU} - y_t^{US}$	0.16	0.85
Δy_t^{EU}	does not Cause	$y_t^{EU} - y_t^{US}$	0.40	0.67
$y_t^{US} - y_t^{EU}$	does not Cause	Δy_t^{US}	0.72	0.50
$y_t^{US} - y_t^{EU}$	does not Cause	Δy_t^{EU}	5.20	0.01**

The F-test does not reject the hypothesis that the Euro Area-US gap does not Granger-cause (and is not Granger-caused by) US output growth. In addition, the F-test does not reject the hypothesis that Euro Area output growth rate does not Granger-cause the Euro Area-US gap but it does reject the hypothesis of Granger causality of the gap on the Euro Area growth rate (results are reported in Table 10).

These results suggest a Euro Area - US dynamics whereby the Euro area rate of growth adjusts itself to the US growth while the US does not, suggesting that the US economy does not respond to shocks specific to the Euro Area[10].

More specifically, the stationarity of the Euro Area - US gap, which indicate that US output and Euro output are cointegrated, suggests a bivariate model on US and Euro output with one common permanent shock. In addition the Granger causality results suggest that the long permanent shock cannot affect contemporaneously the Euro Area while it can affect immediately the US. We can label this shock as US shock and suggest the following model (see also Giannone and Reichlin, 2005):

$$\begin{pmatrix} y_t^{US} \\ y_t^{EU} \end{pmatrix} = \begin{pmatrix} \mu^{US} \\ \mu^{EU} \end{pmatrix} + \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} y_{t-1}^{US} \\ y_{t-1}^{EU} \end{pmatrix} + \begin{pmatrix} b_{11} & 0 \\ b_{21} & b_{22} \end{pmatrix} \begin{pmatrix} u_t^{US} \\ u_t^{EU} \end{pmatrix}$$

On the basis of this model we can now compute impulse response functions of the two shocks (the permanent (US) shock and the long-run neutral shock) on US output, Euro Area output and Euro Area-US gap. Figure 4 plots the impulse responses while Table 11 shows the variance decompositions.

Results imply that after a worldwide shock the US adjusts immediately while Europe reacts slowly reaching the steady state after more than 5 years. Notice also that the other shock, the Euro Area one, is small and transitory. It explains less that 50% of the variance of forecast error at 1-year horizon and less than one-third at 3-years horizon.

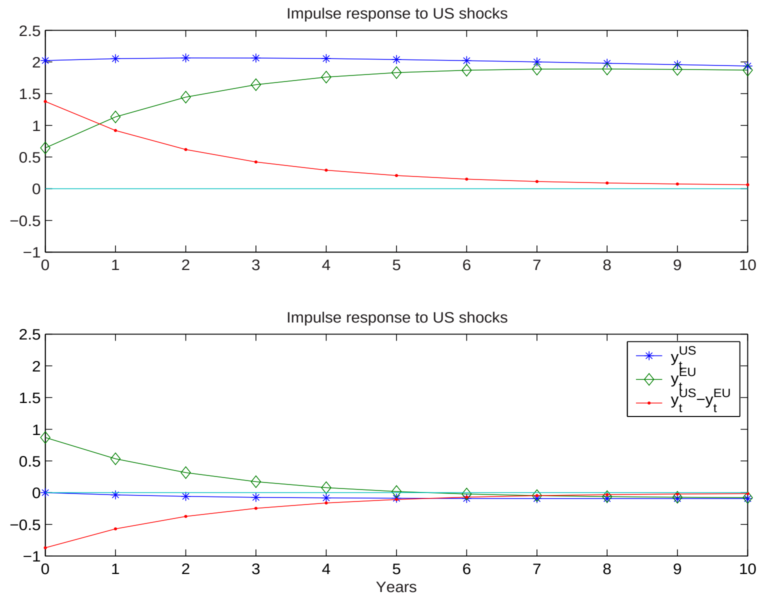
If the non-neutral common shock is interpreted as the world technology shock this result implies that the US economy has a higher ability to absorb technology faster than the Euro economy. The high rapidity with which technology is absorbed in the

[10]Giannone and Reichlin (2005) use the restriction implied by the Granger causality tests to simulate levels of output and verify whether it is possible to reproduce the properties of the dating of business cycle identified from the data (see Table 8). They find that the model reproduces them with a large degree of accuracy.

Table 11: *Real GDP per-capita: Forecast error decomposition% of forecast error variance explained by the Worldwide (US) shock*

	Forecast horizon				
	0y	1y	3y	5y	10y
y_t^{US}	1.00	1.00	1.00	1.00	1.00
y_t^{EU}	0.35	0.62	0.85	0.92	0.96
$y_t^{US} - y_t^{EU}$	0.71	0.72	0.72	0.72	0.72

Figure 4: Impulse responses



US seems to induce high short-term volatility. In the Euro Area, on the other hand, the bulk of the variance is in the long-run because it takes longer to absorb shocks. An alternative interpretation is that the world shock is in fact the US shock. The two hypotheses cannot be distinguished statistically, but the economic implication of the two alternative interpretations is the same.

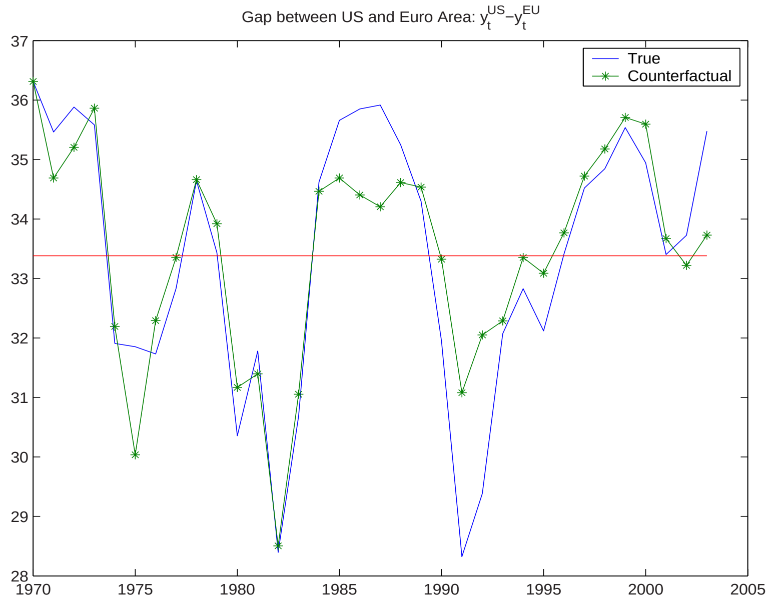
To complete the exercise, we ask counter-factually, what would have the gap been if there had only been worldwide shocks, and no Euro specific shocks. Results are reported in Figure 5.

We can see that the counterfactual and the actual gap are very similar. Moreover, the gap decreases in recessions and increases in expansion which further illustrate our characterizations of the two business cycles.

Collecting all results, we can conclude:

- The world-wide/US shock explains most of the fluctuations of the gap as already

Figure 5: US/Euro Area Gap



noticed by the literature on the world business cycle cited before.

- During recessions, the gap tends to close since Europe reacts slowly to the world-wide shock. The gap opens during the expansions. In the middle of the cycle it reaches its maximum, but then Europe starts caching up; and

- The Euro Area shock reduced the gap during the US recession of the 1990s, probably as a result of the German Unification. However, the Euro Area shock only postponed the European recession. Apart for this episode, the recent period is very much in line with past experience (the variance of European specific shocks has not increased); and

- There is a specific Euro Area cycle, which is different from the US cycle because of the different propagation mechanism. This qualifies the result by Canova et al. (2004) and by Monfort et al. (2004) by distinguishing between origin of the shock (worldwide) and propagation mechanism (Euro Area specific).

4 Business cycle asymmetries and risk sharing: should we care about output synchronization?

So far we have focused on the analysis of output and output per capita and we have not looked at changes in these characteristics during the process of European integration and the establishment of the Euro. In fact, in terms of output there is no clear sign, or at least not yet, of changes in the cyclical characteristics of the Euro Area.

In this section we will ask the question of whether the cross-country correlations of consumption, conditionally on output have changed as the result of the deepening of the European economic integration. What matters for welfare is consumption rather than output. In principle, financial market integration, should make it easier for consumers, to insure against income risk through borrowing and lending and cross-country ownership of financial assets. Sorensen and Yosha (1998) found that less risk is shared in Europe than in the US while Kalemli-Ozcan et al. (2004) found that risk sharing through financial market has increased in the last decade thanks to financial integration.

Table 12 shows some descriptive statistics.

Table 12: Descriptive statistics on Real Individual Consumption

	$\mathrm{Var}(\Delta c_t^i - \Delta c_t^{EU})$			$\mathrm{Var}(\Delta c_t^i)$			$\mathrm{Corr}(\Delta c_t^i, \Delta c_t^{EU})$		
	71-03	71-89	93-03	71-03	71-89	93-03	71-03	71-89	93-03
AT	1.96	2.59	1.30	3.23	3.52	1.56	0.63	0.53	0.43
BE	1.10	1.74	0.41	3.25	4.53	0.65	0.82	0.81	0.65
FI	5.29	2.28	0.68	6.66	2.49	0.59	0.46	0.45	0.38
FR	0.70	0.67	0.41	1.49	1.69	0.75	0.78	0.80	0.69
GE	0.83	0.98	0.30	2.64	2.75	0.97	0.83	0.80	0.84
GR	4.24	6.59	1.52	5.91	9.11	0.53	0.53	0.54	-0.46
IE	8.75	9.27	2.98	9.74	12.48	5.00	0.33	0.54	0.79
IT	1.56	2.05	0.27	3.35	2.68	0.66	0.73	0.54	0.78
LU	4.49	0.86	1.44	5.50	1.78	1.75	0.44	0.75	0.43
NL	2.19	2.43	0.82	3.18	4.35	1.80	0.57	0.67	0.78
PT	10.27	16.55	1.49	13.36	20.50	2.98	0.51	0.49	0.81
SP	2.12	3.28	0.36	4.51	6.47	1.08	0.74	0.74	0.82
EU12	0.00	0.00	0.00	1.59	1.60	0.51	1.00	1.00	1.00
DE	3.59	3.65	2.71	2.83	4.01	1.72	0.19	0.39	-0.25
SE	3.63	3.83	1.42	4.63	4.54	1.80	0.48	0.43	0.46
UK	3.66	3.94	0.32	3.52	4.82	0.50	0.31	0.45	0.68
EU15	0.12	0.13	0.01	1.36	1.55	0.44	0.96	0.96	0.99
US	2.84	3.11	0.25	2.52	3.38	0.71	0.32	0.40	0.81
CA	2.86	2.40	0.67	3.55	4.18	0.53	0.48	0.65	0.36
JP	2.45	2.78	1.74	3.40	4.10	0.66	0.55	0.57	-0.49
OECD	0.76	0.69	0.21	1.16	1.58	0.35	0.73	0.78	0.77

Although the variance of consumption has been declining over time for all countries, the correlation of country consumption growth with the average has increased for some countries and decreased for others.

These numbers, however, cannot be simply interpreted: they are driven by many factors, such as taste shocks for example. A more interpretable measure of risk sharing can be obtained following Asdrubali et al. (1996), ASY from now on. We ask how much variance of output is smoothed by consumption via risk sharing at each period of time (see Sorensen and Yosha, 1998; Kalemli-Ozcan et al., 2004, for an analysis on European countries), i.e. how much the cross-country variance of consumption conditional on output has decreased over time. We consider the sample 1970-2004 and redo some of ASY's calculations on our data.

Let us define: c_t^i the log $\times 100$ of real individual consumption of country i in year t. We estimate (by OLS) the regression:

$$\Delta_h(c_t^i - c_t^{EU}) = \alpha_t + \beta_t \Delta_h(y_t^i - y_t^{EU}) + v_t$$

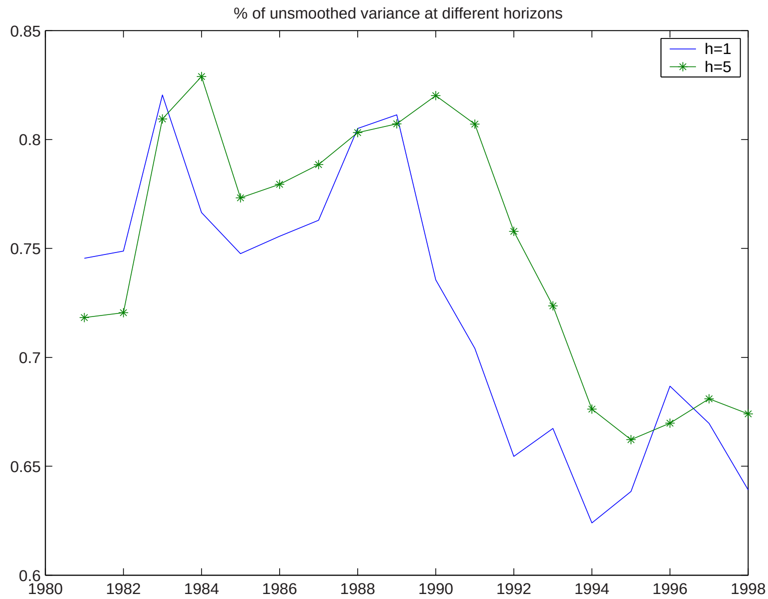
where Δ_h denotes the h-th differences $(1 - L^h)$. The regression coefficient β_t is interpreted as the amount of risk not insured, i.e. the percentage of the variance of GDP that is smoothed out through capital market, credit market and other channels.

Figure 6 plots a smooth version of β_t in time and for the EU12 countries, excluding Luxemburg defined as $\tilde{\beta}_t$:

$$\tilde{\beta}_t = \frac{1}{2m+1} \sum_{j=-m}^{m} \left(1 - \frac{|j|}{2m+1}\right) \beta_{t+j}$$

and $m = 5$ years.

Figure 6: Risk not shared over time



Results show that the ability of sharing risk among European countries goes up in the early 90's when capital and good market integration has significantly accelerated in Europe.

Although the previous calculations provide an interesting rough descriptive statistics, a better measure of risk sharing should control for country heterogeneity in response to common, Area-wide shocks and for the effect of relative prices. The heterogeneity of the responses of countries output and consumption to common shocks could emerge in case of imperfect risk sharing[11]. In addition, relative prices fluctuations, whose nature has changed significantly with the EMU, could have provided an automatic smoothing of the effect of country specific shocks[12] (see for example Obstfeld,

[11]This approach to control for heterogeneity has been proposed by Giannone and Lenza (2004).

[12]We thank Luca Dedola and Fiorella De Fiore for having suggested us to include this control variable.

1994; Hoffmann, 2004).

To this end, we estimate the following panel regression for the whole sample and three sub-samples:

$$\Delta_h(c_t^i - c_t^{EU}) = \alpha_i + \beta_h \Delta_h(y_t^i - y_t^{EU}) + \gamma_i^c \Delta_h c_t^{EU} + \gamma_i^y \Delta_h y_t^{EU} + \gamma_i^R \Delta_h R_t^{i,EU} + v_t^i$$

where $R_t^{i,EU}$ is the real exchange rate between country i and the Euro Area as a whole[13] and Euro-area wide consumption is included as a regressor to control for common taste shocks.

We follow ASY and estimate it using weighted least square so as to downweight countries with a larger idiosyncratic component. We run the regression on all Euro Area countries, excluding Luxembourg. As an alternative, we also estimate the coefficients including in our panel only the six largest Euro Area countries (Germany, France, Italy, Spain, Netherlands and Belgium). Table 13 reports results.

Table 13: Panel estimates of β_h for selected subsamples

	EU 12 (excl. LU)			EU (Largest 6)	
	h=1	h=5		h=1	h=5
1970-2003	0.75 (0.05)	0.77 (0.03)		0.83 (0.07)	0.94 (0.04)
1970-1989	0.80 (0.08)	0.87 (0.04)		0.86 (0.09)	0.91 (0.05)
1990-2003	0.65 (0.07)	0.59 (0.03)		0.70 (0.10)	0.65 (0.08)
1993-2003	0.76 (0.10)	0.59 (0.03)		0.77 (0.12)	0.63 (0.15)

Results from the simple measure of risk sharing are confirmed: risk sharing has increased in the last decade. The result is particularly robust at long horizons, indicating that the increased ability of countries to smooth is particularly significant in response to persistent shocks to output. We should also stress that long horizons results should be more robust to endogeneity issues that may affect these types of reduced form regressions.

We take the results above as an indication that the process of European integration is working and we should worry less than before about asymmetries in output.

5 Conclusions

Six years of history of a monetary union are too short to identify new tendencies of output development since historically gaps GDP per capita have been persistent and it is difficult to distinguish trends from persistent fluctuations around different means. However, these gaps are small and cycles are synchronized.

Heterogeneity is generated by small and persistent idiosyncratic shocks while most output variation is explained by a common shock. A tentative implication of this finding

[13] $R_t^{EU,i} = P_t^{\$EU} - P_t^{\$i}$ where $P_t^{\$i} = \log\left\{C_t^{n,i}/C_t^{r,i}\right\} \times 100$, and $C_t^{r,i}$ and $C_t^{n,i}$ are the nominal consumption and the real consumption, respectively, in country i expressed in US dollars.

is that that national stabilization policy don't have a large role to play in smoothing output and, for the small part of variance generated by idiosyncratic shocks, they should be designed to address low frequency components rather than the business cycle which is mostly common.

What should be a concern for policy is the common characteristic of the European cycle. When the Euro Area is analyzed as an aggregate and compared with the US, it is found that, although a common world shock drives the two cycles, the propagation differs across the two areas: the Euro Area lags the US and its cycle is more persistent, but less volatile. Low growth, persistence of shocks and low volatility are common characteristics of the Euro area and the gap with respect to the US has been stable over the last thirty years.

Facing these historical characteristics, the process of European integration, has however helped to smooth the cross-sectional correlation of consumption conditional on output. This finding supports the hypothesis that, since the early nineties, risk sharing has increased within the Euro Area.

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